TECHNICAL SUPPORT DOCUMENT
NOTICE OF CONSTRUCTION APPROVAL ORDER NO. 11AQ-E3XX
YAHOO! DATA CENTER
2010 EXPANSION PROJECT
FINAL DRAFT FEBRUARY 10, 2011
PUBLIC REVIEW COPY

1. BACKGROUND

Original 2007 Project: Phases 1-3

Yahoo! Inc. submitted a Notice of Construction (NOC) application on January 24, 2007, for the installation of the Yahoo! Data Center at 1010 Yahoo! Way, Quincy, in Grant County. The Yahoo! Data Center will be used as an electronic data storage and data access facility. The primary air contaminant sources at the facility consist of thirteen (13) 2.28-MW MTU Detroit Diesel, Inc. Model 16V4000 G83 B3 diesel engines that power Newage AvK Model DSG 86 L1-4s generators. The servers at the Yahoo! Data Center are cooled by six Evapco Model AT 212-636 two cell evaporative cooling units. The Yahoo! Data Center is supported by associated equipment such as fuel tanks, cooling water storage and treatment, and electrical systems. The MTU Detroit Diesel engines are used to power emergency backup electrical generators in case of a failure of the Grant County PUD hydroelectric power grid.

Notice of Construction Approval Order No. 07AQ-E241 was issued on November 13, 2007. The Order limited operation of each generator to 400 hours per year for combined break-in, maintenance, and emergency backup electrical generation. The diesel engines were restricted to 49,296 gallons/day and 821,600 gallons/year of low sulfur (less than 0.0015 wt %), EPA on-road specification No. 2 distillate diesel oil.

2. EXECUTIVE SUMMARY

Yahoo! submitted a NOC application on September 20, 2010 for the Phase 5 Expansion of the Yahoo! Data Center, hereafter referred to as the Yahoo! Expansion project. The Yahoo! Expansion project consists of the addition of five new building wings approximately 151,000 square feet of sever space. Backup electrical power for the servers will be provided by ten (10) 2.28 electrical-megawatts (eMW) generators powered by MTU Detroit Diesel, Inc. Model 16V 4000 G43 diesel engines.

Notice of Construction Approval Order No. 07AQ-E241 allows 71 tons of nitrogen oxides per year and 2.5 tons of diesel engine exhaust particulate (DEEP). Yahoo! has proposed to reduce total facility-wide emissions from the Yahoo! Data Center. The new nitrogen oxides limit at the Yahoo! Data Center is proposed to be 46 tons per year, and the new DEEP limit at the Yahoo! Data Center is proposed to be 1.6 tons per year. Further, Yahoo! would like to limit fuel usage at the Yahoo! Data Center after the Yahoo! Expansion to 514,351 gallons of on-road specification ultra-low sulfur diesel fuel (down from 821,600 gallons/year). These limits will be achieved by

limiting operations of the expansion engines to 100 hours per year, and the existing engines to 200 hours per year.

Review of the September 20, 2010 NOC application began on September 24, 2010, and a completeness determination was issued on September 30, 2010 by the permit team (Flibbert, Ogulei) in coordination with the Science and Engineering Section Manager (Johnston) and the Eastern Regional Office Section Manager (Wood). A revised NOC application was submitted by Yahoo! on December 2, 2010. The NOC application was considered complete as of December 9, 2010. The final draft Preliminary Determination (i.e., Proposed Decision) was submitted to HQ on December 20, 2010, for review and to complete the third tier review. The Preliminary Determination was issued on February 10, 2011, and public review began on February 14, 2011.

3. PROJECT DESCRIPTION

Yahoo! Inc. submitted a NOC application on September 20, 2010, to expand the Yahoo! Data Center. The expansion project will increase the size of the facility by approximately 151,000 square feet, and will include ten (10) additional 2.28 MWe MTU Detroit Diesel, Inc. Model 16V4000 G83 diesel engines that power Newage AvK Model DSG 86 L1-4s generators. The additional servers at the Yahoo! Data Center expansion will not use evaporative cooling systems. Operation of the ten (10) MTU Detroit Diesel engines will be limited to 100 hours per year each, and will be restricted to no more than 103,551 gallons per year of low sulfur (less than 0.0015 wt %), EPA on-road specification No. 2 distillate diesel oil.

Yahoo! has proposed to reduce operation of existing 13 generators from 400 hours per year to 200 hours per year for combined break-in, maintenance, and emergency backup electrical generation. Yahoo! also proposes to reduce diesel fuel for the existing generators from 821,600 gallons/year to 410,800 gallons per year of low sulfur (less than 0.0015 wt %), EPA on-road specification No. 2 distillate diesel oil. Engine exhaust stack heights will be raised from 15 feet to 20 feet above ground level.

The operating reductions being proposed in the 2010 Yahoo! Expansion project will result in an annual total decrease in permitted engine combustion emissions from the Yahoo! Data Center, and will reduce most potential ambient impacts. Annual permitted facility fuel allocation will decrease from 821,600 gallons as allowed in NOC Approval Order No. 07AQ-E241 to 514,351 gallons under the expansion project approval order. The above two paragraphs are summarized in Table 3.1 as follows:

Table 3.1: Yahoo! Data Center 2010 Expansion Project fuel usage reduction

Project	Order 07AQ-E241 (gallons per year)	Yahoo 2010 Expansion (gallons per year)	Percent reduction (Total)
Phases 1-3	**821,600**	410,800	50%
Phase 5	n/a	103,551	n/a
Total	n/a	**514,351**	37%

The pollutant of greatest concern for this project is diesel engine exhaust particulate (DEEP) and nitrogen dioxide. The facility fuel limitation to 514,351 gallons per year under the Yahoo! Expansion project will result in a diesel emission exhaust particulate and nitrogen dioxide reduction of approximately 0.9 tons per year and 25 tons per year, respectively.

The Yahoo! Data Center expansion project will result in the following Potential to Emit (PTE) for both criteria and toxic air pollutants.

Table 3.2: Potential to Emit (PTE) for the Yahoo! Data Center Expansion Project

Pollutant	**Emission Factor**	**Emission Factor Reference**	**Existing 1 thru 13 PTE[1]**	**Expansion 14 thru 23 PTE**	**Facility PTE**
Criteria Pollutants	g/kW-hr		tons/yr	tons/yr	tons/yr
NO_x	6.12	§89.112a	35	11	46
CO	3.50	§89.112a	13	6.1	19.1
SO_2	15 ppm/gal	MassBalance	80 lb/yr	22 lb/yr	102 lb/yr
$PM_{2.5}$	0.200	§89.112a	1.2	0.35	1.55
VOC	0.282	CEC-05-049	80 lb/yr	349 lb/yr	429 lb/yr
Toxic Air Pollutants (TAPs)					
Primary NO_2	0.62	10% NO_x	3.5	1.1	4.6
DEEP[2]	0.200	$PM_{2.5}$	1.2	0.35	1.6
Carbon monoxide	3.50	CO above	13	6.1	19.1
Sulfur dioxide	15 ppm/gal	SO_2 above	4.0E-02	1.0E-02	5.1E-02
Speciated TAPs	lbs/MMBtu				
Acrolein	7.88E-06	AP-42 §3.4	2.1E-04	5.59E-05	2.7E-04
Benzene	7.76E-04	"	2.1E-02	5.5E-03	2.6E-02
Toluene	2.81E-04	"	7.5E-03	1.99E-03	9.5E-03
Xylenes	1.93E-04	"	5.2E-03	1.37E-03	6.5E-03
Formaldehyde	7.89E-05	"	2.1E-03	5.6E-04	2.7E-03
Acetaldehyde	2.52E-05	"	6.7E-04	1.79E-04	8.5E-04
Poly Aromatic Hydrocarbons (PAHs)					
Naphthalene	1.30E-04	"	3.5E-03	9.22E-04	4.4E-03
Benz(a)anthracene	6.22E-07	"	1.7E-05	4.41E-06	2.1E-05
Chrysene	1.53E-06	"	4.1E-05	1.1E-05	5.2E-05
Benzo(b)fluoranthene	1.11E-06	"	3.0E-05	7.9E-06	3.8E-05
Benzo(k)fluoranthene	2.18E-07	"	5.8E-06	1.55E-06	7.4E-06
Benzo(a)Pyrene	2.57E-07	"	6.9E-06	1.82E-06	8.7E-06
Indeno(1-3cd)pyrene	4.14E-07	"	1.1E-05	2.94E-06	1.4E-05
Dibenz(a,h)anthracene	3.46E-07	"	9.2E-06	2.45E-06	1.2E-05

[1] PTE (Potential to Emit) accounts for reduction in fuel use from the existing engines.
[2] DEEP (diesel engine exhaust particulates)

The 23 Yahoo! Data Center engines are limited to the hours of operation, fuel limits, and number of engines operating concurrently. The 13 existing engines are limited as follows in Table 3.3a, and the 10 expansion engines are limited as follows in Table 3.3b:

Table 3.3a: 13 Existing Engine Operating Restrictions				
Operating Activity	Hours/year per generator	Operating Load (%)	Diesel Fuel Gallons/year	# Operating Concurrently
Maintenance Testing[1]	12	100	24,648	1
Load Testing	4	100	8216	1
Electrical Bypass	36	100	73,944	2
Power Outage	148	100	303,992	13
Total	200		410,800	

Table 3.3b: 10 Expansion Engine Operating Restrictions				
Operating Activity	Hours/year per generator	Operating Load (%)	Diesel Fuel Gallons/year	# Operating Concurrently
Maintenance Testing[1]	12	10	1896	1
Load Testing	4	100	5892	1
Electrical Bypass	36	2 at 40, 1 at 80	43,020	2
Power Outage	48	8 at 90, 2 at 10	52743	10
Total	100		103,551	

[1]Maximum of one hour per month operation.

Total emissions from the existing cooling towers shall be less than or equal to the amounts contained in Table 3.4:

Table 3.4: Cooling Towers Emission Limits			
Pollutant	**Water supply conc. Mg/l**	**Recirc. water conc. Mg/l**	**Emission rate Lbs/yr**
Hexavalent Chromium*	0.00083	0.0023	0.0054
Arsenic	0.025	0.070	0.16
Barium	0.2	0.56	1.29
Nickel	0.05	0.14	0.32
Bromine	Na	75	173
TDS as PM_{10}	Na	1072	2,466.17

* There shall be no hexavalent chromium added to treat the cooling tower water. This value is a result of hexavalent chromium in the City of Quincy water supply.

There are no small emergency engines to power fire water pumps or cooling water pre-treatment facility. Washington Administrative Code (WAC) 173-400-110(4)(h)(xxxix), as adopted on the date of this Order, exempts all emergency engines below 500 bhp. However, emissions from any potential small engines will be added to the annual emission inventory.

4. APPLICABLE REQUIREMENTS

The proposed by Yahoo! Data Center 2010 Expansion project qualifies as a new source of air contaminants as defined in Washington Administrative Code (WAC) 173-400-110 and WAC 173-460-040, and requires Ecology approval. The installation and operation of the Yahoo! Data Center is regulated by the requirements specified in:

4.1 Chapter 70.94 Revised Code of Washington (RCW), Washington Clean Air Act,
4.2 Chapter 173-400 Washington Administrative Code (WAC), General Regulations for Air Pollution Sources,
4.3 Chapter 173-460 WAC, Controls for New Sources of Toxic Air Pollutants, and
4.4 Title 40 CFR Part 60 Subpart IIII

All state and federal laws, statutes, and regulations cited in this approval shall be the versions that are current on the date the final approval order is signed and issued.

5. BEST AVAILABLE CONTROL TECHNOLOGY

Best Available Control Technology (BACT) is defined[1] as "*an emission limitation based on the maximum degree of reduction for each air pollutant subject to regulation under chapter 70.94 RCW emitted from or which results from any new or modified stationary source, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant. In no event shall application of the "best available control technology" result in emissions of any pollutants which will exceed the emissions allowed by any applicable standard under 40 CFR Part 60 and Part 61….*"

For this project, Ecology is implementing the "top-down" approach for determining BACT for the proposed diesel engines. The first step in this approach is to determine, for each proposed emission unit, the most stringent control available for a similar or identical emission unit. If that review can show that this level of control is not technically or economically feasible for the proposed source, then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be

[1] RCW 70.94.030(7) and WAC 173-400-030(12)

eliminated by any substantial or unique technical, environmental, or economic objections.[2] The "top-down" approach shifts the burden of proof to the applicant to justify why the proposed source is unable to apply the best technology available. The BACT analysis must be conducted for each pollutant that is subject to new source review.

The proposed diesel engines will emit the following regulated pollutants which are subject to BACT review: nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM, PM_{10} and $PM_{2.5}$) and sulfur dioxide.

5.1 BACT ANALYSIS FOR NOx

Yahoo! reviewed EPA's RACT/BACT/LAER Clearinghouse (RBLC) database to look for NOx add-on controls recently installed on internal combustion engines. The RBLC provides a listing of BACT determinations that have been proposed or issued for large facilities within the United States, Canada and Mexico. Yahoo!'s review of the RBLC found that urea -based selective catalytic reduction (SCR) was the most stringent add-on control option demonstrated on diesel engines. The application of the SCR technology for NOx control was therefore considered the top-case control technology and evaluated for technical feasibility and cost-effectiveness.

The most common BACT determination identified in the RBLC for NOx control was compliance with EPA Tier 2 standards using engine design, including exhaust gas recirculation (EGR) or fuel injection timing retard with turbochargers. Other NOx control options identified through a literature review include water injection and NOx adsorbers.

5.1.1 ***Selective Catalytic Reduction.*** The SCR system functions by injecting a liquid reducing agent, such as urea, through a catalyst into the exhaust stream of the diesel engine. The urea reacts with the exhaust stream converting nitrogen oxides into nitrogen and water. The use of a lean ultralow sulfur fuel is required to achieve good NOx destruction efficiencies. SCR can reduce NOx emissions by up to 90-95 percent while simultaneously reducing hydrocarbon (HC), CO and PM emissions.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500^{o}C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 20 to 30 minutes after engine start up, especially during maintenance, and testing loads. There are also complications of managing and controlling the excess ammonia (ammonia slip) from SCR use. Because backup engines typically experience long idle periods between operations, urea crystallization inside reagent distribution lines could cause damage to the SCR system and to the engine.

Yahoo! has evaluated the cost effectiveness of installing and operating SCR systems on each of the proposed diesel engines. The analysis indicates that the use of SCR systems

[2] J. Craig Potter, EPA Assistant Administrator for Air and Radiation memorandum to EPA Regional Administrators, "Improving New Source Review (NSR) Implementation", December 1, 1987.

would cost approximately $15,018 per ton of NOx removed from the exhaust stream based on a worst-case 48-hour power outage. Assuming a typical 3-hour power outage, the cost effectiveness becomes $29,748 per ton on NOx removed. A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from $143 to $9,473 per ton of NOx removed. Ecology concludes that while SCR is a demonstrated emission control technology for prime diesel engines, it is not economically feasible for this project. Therefore, Ecology rejects this NOx control option as BACT.

5.1.2 ***NOx adsorbers.*** The use of NOx adsorbers (sometimes called lean NOx traps) is a catalytic method being developed and tested by diesel engine manufacturers to reduce NOx emissions, primarily from mobile sources. The NOx adsorber contains a catalyst (e.g., zeolite or platinum) that is used to "trap" NOx (NO and NO_2) molecules found in the exhaust. NOx adsorbers can achieve NOx reductions greater than 90% at typical steady-state exhaust gas temperatures.

However, as of this writing, NOx adsorbers are experimental technology and are, therefore, very expensive. Additionally, a literature search did not reveal any indication that this technology is commercially available for stationary backup generators. Thus, Ecology rejects NOx adsorbers as BACT for the proposed diesel engines.

5.1.3 ***Combustion Controls and Tier 2 compliance.*** Diesel engine manufacturers typically use proprietary combustion control methods to achieve the emission reductions needed to meet applicable EPA tier standards. Common controls include fuel injection timing retard and exhaust gas recirculation. Injection timing retard reduces the peak flame temperature and NOx emissions, but may lead to higher fuel consumption. Yahoo! will install MTU Detroit Diesel engines that will use a combination of combustion control methods, including fuel injection timing retard, to comply with EPA Tier-2 emission limits.

5.1.4 ***Other control options***. Other NOx control options, such as water injection, were rejected because there was no indication that they are commercially available and/or effective in new large diesel engines.

5.1.5 **BACT determination for NOx**

Ecology determines that BACT for NOx is the use of good combustion practices, an engine design that incorporates fuel injection timing retard, turbocharger and a low-temperature aftercooler, EPA Tier-2 certified engines, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.

5.2 BACT ANALYSIS FOR PARTICULATE MATTER, CARBON MONOXIDE AND VOLATILE ORGANIC COMPOUNDS

Yahoo! reviewed the available published literature and the RBLC and identified the following demonstrated technologies for the control of diesel engine exhaust particulate, carbon monoxide and volatile organic compounds from the proposed diesel engines:

5.2.1 ***Diesel particulate filters (DPFs)***. These add-on devices include passive and active DPFs, depending on the method used to clean the filters (i.e., regeneration). Passive filters rely on a catalyst while active filters typically use continuous heating with a fuel burner to clean the filters. The use of DPFs to control diesel engine exhaust particulate emissions has been demonstrated in multiple engine installations worldwide. Particulate matter reductions of up to 85% or more have been reported. Therefore, this technology was identified as the top case control option for diesel engine exhaust particulate emissions from the proposed engines.

Yahoo! has evaluated the cost effectiveness of installing and operating DPFs on each of the proposed diesel engines. The analysis indicates that the use of DPFs would cost approximately $217,941 per ton of engine exhaust particulate removed from the exhaust stream, assuming a single 48 hours power outage. A previous survey by Ecology found that none of the permitting agencies surveyed had required installation of a particulate matter control device (as BACT) that was expected to cost more than $23,200 per ton of particulate removed.

Since the estimated DPF cost effectiveness value for the proposed Yahoo! project far exceeds the $23,200 per ton upper limit, Ecology concludes that the use of DPFs is not economically feasible for this project. Therefore, Ecology rejects this control option as BACT for particulate matter.

5.2.2 ***Diesel oxidation catalysts***. This method utilizes metal catalysts to oxidize carbon monoxide, particulate matter, and hydrocarbons in the diesel exhaust. Diesel oxidation catalysts (DOCs) are commercially available and reliable for controlling particulate matter, carbon monoxide and hydrocarbon emissions from diesel engines. While the primary pollutant controlled by DOCs is carbon monoxide (approximately 90% reduction), DOCs have also been demonstrated to reduce up to 30% of diesel engine exhaust particulate emissions, and more than 50% of hydrocarbon emissions.

Yahoo! has evaluated the cost effectiveness of installing and operating DOCs on each of the proposed diesel engines. If the cost effectiveness of DOC use is evaluated only using the total amount of particulate matter reduced, the normalized operational cost estimate becomes $442,500 per ton assuming a single annual 48 hours power outage. The corresponding DOC cost effectiveness value assuming only carbon monoxide destruction is approximately $6,066 per ton of carbon monoxide removed.

Diesel Oxidation Catalyst technology is commercially available. A previous survey by Ecology found that the permitting agencies surveyed have required installation of carbon monoxide controls as BACT on other types of emission units, with expected operational costs ranging from $300 to $9,795 per ton of carbon monoxide removed. The upper level of that range is suspect and it is possible that that number actually reflects California BACT which is typically equivalent to a Lowest Achievable Emissions Rate (LAER) limit. In Washington, costs for controlling CO from combined cycle natural gas electric generating facilities are usually in the $3,500 to $5,000 range. The cost effectiveness estimates calculated for the Yahoo! project are outside this range when all pollutants to be controlled are considered, or if only carbon monoxide is considered.

5.2.3 **BACT Determination for Particulate Matter, Carbon Monoxide and Volatile Organic Compounds**

Ecology determines BACT for particulate matter, carbon monoxide and volatile organic compounds is restricted operation of the EPA Tier-2 certified engines, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.

5.3 BACT ANALYSIS FOR SULFUR DIOXIDE

5.3.1 Ecology and Yahoo! did not find any add-on control options commercially available and feasible for controlling sulfur dioxide emissions from diesel engines. Yahoo!'s proposed BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel (15 ppm by weight of sulfur). Using this control measure, sulfur dioxide emissions would be limited to 0.011 tons per year.

5.3.2 **BACT Determination for Sulfur Dioxide**

Ecology determines that BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

5.4 BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to toxic air pollutants.[3] The procedure for determining tBACT follows the same procedure used above for determining BACT. Under state rules, tBACT is required for all toxic air pollutants for which the increase in emissions will exceed de minimis emission values as found in WAC 173-460-150.

For the proposed project, tBACT must be determined for each of the toxic air pollutants listed in Table 1 below. As illustrated by Table 1, Ecology has determined that compliance with BACT, as determined above, satisfies the tBACT requirement.

[3] WAC 173-460-020

Table 5.4. tBACT Determination

Toxic Air Pollutant	tBACT
Acetaldehyde	Compliance with the VOC BACT requirement
Acrolein	Compliance with the VOC BACT requirement
Benzene	Compliance with the VOC BACT requirement
Benzo(a)pyrene	Compliance with the VOC BACT requirement
1,3-Butadiene	Compliance with the VOC BACT requirement
Carbon monoxide	Compliance with the CO BACT requirement
Diesel engine exhaust particulate	Compliance with the PM BACT requirement
Formaldehyde	Compliance with the VOC BACT requirement
Nitrogen dioxide	Compliance with the NOx BACT requirement
Sulfur dioxide	Compliance with the SO_2 BACT requirement
Toluene	Compliance with the VOC BACT requirement
Total PAHs	Compliance with the VOC BACT requirement
Xylenes	Compliance with the VOC BACT requirement

6. AMBIENT AIR MODELING

Ambient air quality impacts at and beyond the property boundary were modeled using EPA's AERMOD dispersion model, with EPA's PRIME algorithm for building downwash. For purposes of demonstrating compliance with the national ambient air quality standards (NAAQS) and acceptable source impact levels (ASILs), it was assumed the entire Yahoo! Data Center would experience 48 hours over 2 consecutive days of power outage, in which case eight (8) backup engines were assumed to operate at 90% load at the same time, and two (2) engines were assumed to operate at 10% load. For engine testing, Yahoo! assumed that all ten (10) engines would not run concurrently and would operate at 10% load.

6.1 AERMOD Model Assumptions

The AERMOD model used the following data and assumptions:

6.1.1 Five years of sequential hourly meteorological data (2001–2005) from Moses Lake Airport were used. Twice-daily upper air data from Spokane were used to define mixing heights.

6.1.2 Digital topographical data (in the form of Digital Elevation Model files) for Grant County were obtained from the Web-Geographic Information System website.

6.1.3 Each generator was modeled with a stack height of 30- feet above local ground.

6.1.4 The existing data center building, the proposed new expansion project building additions, and each expansion generator's exhaust stack data were included to account for building downwash.

6.1.5 The receptor grid for the AERMOD modeling was established using a 10-meter grid spacing along the facility boundary extending to a distance of 350 meters from each facility boundary. A grid spacing of 25 meters was used for a distance of 350 to 800 meters from the source, and 50 meters for a distance of 800 to 3,000 meters from the

source. Concentrations were modeled for receptor heights of 1.4 meters to approximate the breathing zone..

6.1.6 1-hour NO_2 concentrations at and beyond the facility boundary were modeled using the Plume Volume Molar Ratio Method (PVMRM) module, with default concentrations of 40 parts per billion (ppb) of background ozone, and an equilibrium NO_2 to NOx ambient ratio of 90%. For purposes of modeling NO_2 impacts, the primary NOx emissions at the stack exit were assumed to consist of 10% NO_2 and 90% nitric oxide by mass.

6.1.7 Dispersion modeling is sensitive to the assumed stack parameters (i.e., flow rate and exhaust temperature). The stack temperature and stack exhaust velocity at each generator stack were set to values corresponding to the engine loads for each type of testing and power outage scenario.

Except for diesel engine exhaust particulate and nitrogen dioxide which were predicted to exceed its ASIL, AERMOD model results show that no NAAQS or ASIL will be exceeded at or beyond the property boundary. As required by WAC 173-40-090, emissions of diesel engine exhaust particulate and nitrogen dioxide are further evaluated in the following section of this document.

6.2 Demonstrating Compliance with the 1-hour NO_2 and 24-hour $PM_{2.5}$ NAAQS

WAC 173-400-113(1) requires that before Ecology approves a project that is subject to new source review under WAC 173-400-110, the proposed new source or modification must demonstrate that allowable emissions from the project will not delay the attainment date for an area not in attainment or cause or contribute to a violation of any ambient air quality standard. The area in which Yahoo!'s project will be located (i.e., Quincy, Grant County) is currently classified as being in attainment or unclassifiable with respect to all state or national ambient air quality standards (NAAQS).

Although Ecology believes Yahoo! has demonstrated in the Notice of Construction (NOC) application that the proposed expansion will not cause or contribute to a violation of any ambient air quality standard, we are proposing safeguards in our draft approval order to assure continuous compliance with the NAAQS. We are proposing a requirement that Yahoo! conduct initial and periodic emissions testing of the 10 new engines. The basis for this proposed requirement is further explained below.

6.2.1 Nature of the 1-hour NO_2 and 24-hour $PM_{2.5}$ NAAQS

The 1-hour NO_2 NAAQS is based on the 3-year average of the 98^{th} percentile daily 1-hour concentrations in each year. The 24-hour $PM_{2.5}$ NAAQS is based on the 3-year average of the 98^{th} percentile 24-hour concentrations in each year. To attain the 1-hour NO_2 standard, the 3-year average of the 98^{th} percentile of the daily maximum 1-hour average at each ambient monitor within an area must not exceed 100 parts per billion (or approximately 188 $\mu g/m^3$). Similarly, to attain the 24-hour $PM_{2.5}$ standard, the 3-year average of the 98^{th} percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$.

EPA has interpreted that the "98th percentile" concentration in any year is equivalent to the 8th highest concentration for that year. Thus in new source review, an applicant must demonstrate through dispersion modeling that:

- the 3-year average of the 8th highest daily maximum 1-hour NO_2 average concentration at each modeled receptor will not exceed 100 parts per billion (i.e., about 188 µg/m^3), and
- the 3-year average of the 8th highest 24-hour average concentrations at each modeled receptor will not exceed 35 µg/m^3.

6.2.2 Ecology's Position Regarding Compliance with the 1-hour NO_2 and 24-hour $PM_{2.5}$ NAAQS for Data Center Emergency Generators

To demonstrate compliance with the 1-hour NO_2 and the 24-hr $PM_{2.5}$ NAAQS, Ecology typically utilizes the 1st-highest 1-hour NO_2 concentration obtained during scheduled maintenance testing as an estimate of the 8th highest daily maximum 1-hour concentration in each of the 5 calendar years modeled. The 3-year average of the highest 1-hour or 24-hour concentrations in each year would then be compared to the NAAQS. In doing this, we have generally assumed that emergency power outages and other unscheduled or scheduled operation of the engines will contribute to no more than 7 daily high concentrations. Note that power outages, however brief, can realistically occur on more than two days in a year.

6.2.3 Yahoo!'s Modeled Impacts

The following table shows Yahoo!'s modeled estimate of the average of the highest 3-year 1-hour NO_2 and 24-hour $PM_{2.5}$ modeled concentrations, including background.

Nth high value	**1-hour NO_2 highest 3-year average (µg/m^3)**		**24-hour $PM_{2.5}$ highest 3-year average (µg/m^3)**	
	Startup or monthly testing maximum 1-hour NO_2 concentration	Annual load testing maximum 1-hour NO_2 concentration*	Startup or monthly testing maximum 24-hour $PM_{2.5}$ concentration	Annual load testing maximum 24-hour $PM_{2.5}$ concentration*
1st highest	197	236	21.4	21.6
2nd highest	162	193	21.3	21.5
3rd highest	156	185	21.2	21.3
4th highest	148	175	21.2	21.3

**The load testing concentration was obtained by scaling the startup testing concentration by the load testing to startup testing ratio of emission rates. Annual load testing will not occur in the same year as startup testing.*

In demonstrating that the data center expansion will not cause or contribute to an exceedance of the NO_2 NAAQS, Yahoo! assumed that unplanned power outages will only occur on two days in any year and that scheduled startup or monthly testing will account for up to 4 days of each year's highest 1-hour NO_2 concentration. See Table A3-3 of the NOC application. Using this

approach, Yahoo! treated the 4th-highest 1-hour NO_2 concentration for any given day during startup testing (when only one engine is operating at a time at 83% load) as an estimate of the 98th percentile 1-hour NO_2 concentration for that year.

Ecology believes that this modeling approach, while it may be appropriate if power outages were predictable, could pose continuous compliance problems with the NO_2 NAAQS if power outages occurred on more than two days in a year. While it is very unlikely to have 7 or more days with power outages in any given year, we are convinced that the possibility of having more than two days with brief power outages (of a few minutes at a time) at the Yahoo! facility is real.

As shown in the above table, if the 1st-highest daily 1-hour NO_2 concentration achieved during testing is used to demonstrate compliance with the NO_2 NAAQS, the NO_2 NAAQS could be violated. The modeled maximum 1-hour NO_2 concentrations (including background) would be approximately 200 and 235 µg/m^3 during start-up testing and annual load testing, respectively. Both of these values exceed the 1-hour NO_2 NAAQS of 188 µg/m^3.

Based on Yahoo!'s proposed operating scenarios (Table A3-3 of the NOC application), modeling the 1st-highest 1-hour concentration would allow up to 5 or 7 different days of brief power outages in a start-up year or standard operating year, respectively. However, based on what we currently know about historical and expected electrical grid reliability near the Yahoo! facility, it is reasonable to assume that brief power outages are not likely to occur on more than 4 different days in any given year.

6.2.4 Ecology's Conclusion Regarding NAAQS Compliance by the Yahoo! Facility

After reviewing historical power outage information at the Yahoo! facility and the proposed operating scenarios for the new engines, Ecology believes that brief power outages would likely not occur on more than 4 different days. Therefore, for the purpose of demonstrating compliance with the 1-hour NO_2 and 24-hour $PM_{2.5}$ NAAQS, four days is a realistic assumption for the number of days with brief power outages at the Yahoo! facility. Thus:

- In a startup testing year, the first through fourth highest daily 1-hour concentrations would occur during power outages, the fifth and sixth highest 1-hour concentrations would occur during site integrated testing, while the seventh and eighth highest 1-hour concentrations would occur during regular startup testing. In this case, the 2nd highest daily 1-hour NO_2 concentration during testing would approximately be equivalent to the overall 8th highest concentration for that year. This value is **162** µg/m3 in the above table, which is less than the NO_2 NAAQS.

- In a standard year, the first through fourth highest daily 1-hour concentrations would occur during power outages and the fifth through eighth highest 1-hour concentrations would occur during annual load bank testing. In this case, the 4th highest 1-hour NO_2 concentration during testing would approximately be equivalent to the overall 8th highest concentration for that year. This value is **175** µg/m^3 in the above table, which is less than the NO_2 NAAQS.

6.2.5 Compliance Testing Requirement

To assure continuous compliance with the 1-hour NO_2 emission limit and thus create more certainty that Yahoo! will not cause or contribute to an exceedance of the 1-hour NO_2 NAAQS, Ecology is proposing a requirement for initial and periodic combustion gas testing of the engines using an approved portable instrument analyzer or other approved test method. See proposed Approval Condition 4.2.

The proposed emissions testing will measure emission rates of specific flue gas components (NO, NO_2, CO, SO_2, and O_2) at specific operating loads. This testing will serve to verify the reliability of the assumed NO_2 emission factors and as an indicator of proper operation of the engines. Additional operation of the engines for the sole purpose of this emissions testing is not allowed.

Yahoo! may propose other measures to be implemented in lieu of engine emissions testing, if those measures would significantly reduce the modeled NO_2 and $PM_{2.5}$ impacts from the facility.

7. THIRD TIER REVIEW FOR DIESEL ENGINE EXHAUST PARTICULATE

As discussed above, proposed emissions of diesel engine exhaust particulate (DEEP) and nitrogen dioxide (NO_2) from the 10 additional engines exceed the regulatory trigger level for toxic air pollutants (also called an Acceptable Source Impact Level, (ASIL). A third tier review is required for DEEP and NO_2 in accordance with WAC 173-460-100.

Yahoo!'s existing computer data center is currently one of three data centers operating in the rural town of Quincy, WA. The three data centers utilize dozens of large (>2 MW) diesel engines to supply backup power in support of data center operations. Additionally, due to the April, 2010 enactment of the *Computer Data Centers – Sales and Tax Exemption* law in Washington State, several companies have expressed interest in expanding existing or developing new data centers in Quincy. Thus, more large diesel-powered generators will be needed to supply backup power for the additional data centers.

Large diesel-powered backup engines emit DEEP, which is a high priority toxic air pollutant in the state of Washington. In light of the potential rapid development of other data centers in the Quincy area, and recognizing the potency of DEEP emissions, Ecology decided to evaluate Yahoo!'s proposal on a community-wide basis. The community-wide evaluation approach considers the cumulative impacts of DEEP emissions resulting from Yahoo!'s project, and includes consideration of prevailing background emissions from existing permitted data centers and other DEEP sources in Quincy. This evaluation was conducted under the third tier review requirements of WAC 173-460-100.

The results of Ecology's evaluation of cumulative risks associated with Yahoo!'s project are included in a separate technical support document. Please refer to that technical support

document for a discussion and evaluation of the risks associated with diesel engine exhaust particulate emitted by Yahoo!.

8. CONCLUSION

Based on the above analysis, Ecology concludes that operation of the 10 generators will not have an adverse impact on air quality. Ecology finds that Yahoo! has satisfied all requirements for NOC approval.

******END OF YAHOO! 2010 EXPANSION TSD** ****